Appendix E – H2A Hydrogen Analysis Model

Introduction

The H2A model, which stands for Hydrogen Analysis model, was developed as a collaborative effort of the Department of Energy, national laboratories and key industry analysts to provide consistent analysis of hydrogen production and delivery technologies and systems to guide research and development efforts. The objective of H2A is to improve the transparency and consistency of the analysis approaches, enable technologies to be compared on a "level playing field" and seek better validation of analysis studies by industry. To meet this objective, H2A has developed models to assess the economics of hydrogen production and delivery scenarios.

Approach

The H2A Production Cost Analysis Tool

To address the need for transparent reporting and consistent methodology, the H2A production modeling tool was developed to assess the hydrogen cost for central and distributed hydrogen production technologies. The user defines the characteristics of the process being studied, including process design, capacity, capacity factor, efficiency, feedstock requirements and capital and operating costs. The tool includes agreed upon H2A reference values for all key economic and financial parameters but users can vary these parameters for their own purpose. These parameters include: internal rate of return, plant life, feedstock costs, tax rates and depreciation schedules. The calculation part of the tool uses a standard discounted cash flow rate of return analysis methodology to determine hydrogen cost for the desired internal rate of return (10% is the H2A reference value).

Assumptions and data from each case studied using the H2A production modeling tool will be transparent and easily accessed. The tool is programmed into a standardized Excel spreadsheet (Summary Workbook Spreadsheet) that documents the following:

- Original source(s) of data (i.e., report title, authors, etc.)
- Basic process information (feedstock and energy inputs, size of plant, co-products produced, etc.)
- Process flowsheet and stream summary (flowrate, temperature, pressure, composition of each stream)
- Technology performance assumptions (e.g., process efficiency and hydrogen product conditions)
- Economic assumptions (discount rate, depreciation schedule, plant lifetime, income tax rate, capacity factor, etc.)
- Capital and operating costs
- Calculation of the discounted cash flow (the calculation procedure will be built into the standardized spreadsheet so that all technologies use the same methodology)
- Results (plant-gate hydrogen selling price and cost contributions in \$/kg H_2, operating efficiency, total fuel and feedstock consumption, and emissions)
- Sensitivity of the results to assumptions (e.g., feedstock cost, co-product selling price, capital cost, operating costs, internal rate of return, conversion efficiencies, etc.)

This production modeling tool also will facilitate the explanation of any differences between the final results of this effort and previously published results.

Technologies can be characterized at various future points in time, with the assumption that the performance and cost will change in the future. The tool includes projected costs for various potential feedstocks and utilities from 2000-2070 based on EIA and other analysis projections.

The tool allows the analysis to be done on a well-to-gate basis for central-plant technologies and a well-to-pump basis for distributed technologies. In other words, the performance characteristics of the technology (cost, energy consumption, emissions) include all upstream activities associated with the plant. This is straightforward relative to costs (because the cost of upstream activities are included in the price of inputs to the plant). It is less straightforward for energy use, efficiency and emissions. To help assess the energy and environmental impacts of the upstream activities, the H2A effort will use a model developed by Argonne National Laboratory called GREET, which contains a large database of environmental and energy data for characterizing the total lifecycle energy and emissions of various transportation processes (see: http://www.transportation.anl.gov/greet/index.html).

The H2A Production Model will be available for public use in the first quarter of 2005 and will be accessed from the Program's Web site (http://www.eere.energy.gov/hydrogenandfuelcells).

Delivery Analysis

H2A delivery models are in the development stage. Once completed, this part of the H2A effort will provide analysis fundamentals for increased understanding of delivery component costs and full delivery infrastructure costs. Three modes of hydrogen transport will be included in the initial models: compressed gas truck, liquid hydrogen truck and gas pipeline.

The H2A Delivery Component Model has information on and calculates the cost contribution of the various components of hydrogen delivery infrastructure. These include:

- Compressed hydrogen gas truck (tube trailer)
- Liquid hydrogen truck
- Hydrogen compression
- Hydrogen pipelines
- Liquefiers
- Liquid hydrogen storage tanks
- Gaseous hydrogen storage tanks
- Compressed hydrogen gas truck terminal
- Liquid hydrogen truck terminal
- Gaseous hydrogen underground geological storage

In addition to the H2A Delivery Component Model, a Delivery Scenario Model is being developed. This model will have the capability of laying out a full hydrogen delivery infrastructure for particular hydrogen delivery scenarios. One such scenario might be the delivery infrastructure from a central plant to a large city of a million people with a certain hydrogen fuel cell vehicle market share. The model will provide a discounted cash flow analysis to calculate the cost of hydrogen delivery for that scenario. There will be a wide choice of delivery scenarios when the model is fully developed.

All of the H2A tools will be compatible and consistent. They will contain the same analysis approach that utilizes consistent data and financial parameter default values.